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US-A- 3 671 685
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Description

The invention relates to an electro-acoustic transducer of the kind suitable for insertion in the ear.

So called inner ear type headphone units have been previously proposed in which a housing enclosing an electro-acoustic transducer device is inserted into and attached within the concha of the ear of the user.

Such a unit is shown in Fig. 1 of the accompanying drawings and includes a housing 102 enclosing a speaker unit which is the electro-acoustic device. The housing 102 is formed of a size such that it can be introduced into the ear's concha and has an open sound-radiating surface of the speaker unit 101. A connecting cord 103 supplying acoustic signals to the speaker unit 101 has its end 104 connected as by soldering to an input terminal 105 of the speaker unit 101. The connecting cord 103 exits the housing 102 to the outside by way of a cord extraction opening 106.

An ear pad ring 107 is provided at the portion of the housing 102 facing to the ear's concha and on the perimeter of the front side of the speaker unit 101. The ear pad ring 107 is engaged with a rib 102a provided at the perimeter of the open portion of the housing 102, and is attached to this portion by auxiliary securing means, such as adhesion.

The housing 102 is formed of a relative hard material since it has to hold the speaker unit 101 in position and provide determined acoustic effects. On the other hand, the ear pad ring 107 is formed of a relatively soft material for providing good contact feel with the inner wall of the ear's concha and to permit insertion of the ring into ear conchae of different sizes.

In order that the portion of the connection cord 103 extracted through the extraction opening 106 may be protected from accidents such as cord breakage caused by repeated cord flexure, a cylindrical cord bush 108 is provided on the housing 102 on a line of extension of the cord extraction opening 106. The cord bush 108 is formed of a relatively soft material, similarly to the ear pad ring 107, and provided with peripheral slots 109 to allow the bush 108 easily to be flexed. The portion of the connection cord 103 extracted through the cord extraction opening 106 may be bent smoothly as it is encased within the cord bush 108 when a stress is applied from outside to prevent accidents, such as breakage of the cord at the edge of the cord extraction opening 106.

In the operation of the above described headphone unit, when the housing 102 is introduced into the ear's concha, the ear pad ring 107 is deformed under a pressure applied from the inner wall of the ear's concha. The ear pad ring 107 closes the ear's concha completely by abutting on the inner wall of the ear's concha by its own resiliency. With the ear's concha thus closed completely, the sound may be repro-

duced by the speaker unit 101 with optimum electro-acoustic characteristics.

It will be noted that, since the size of the ear's conchae will differ from one person to another it may occur that the above described headphone unit cannot be introduced into the ear's concha, or the ear's concha cannot be closed satisfactorily by the ear pad ring 107, with the result that optimum acoustic characteristics are not obtained.

That is, with the outside diameter d_1 of the ear pad ring 107, the ear pad ring cannot be deformed to an outside diameter d_0 of the rib 102a. Therefore, when the ear's concha has an inside diameter less than the outside diameter d_0 of the rib 102a, the housing 102 cannot be introduced into the ear's concha. On the other hand, when the ear's concha has an inside diameter larger than the outside diameter d_1 of the ear pad ring 107, a void or gap remains between the ear pad ring 107 and the inner wall of the ear's concha, so that the ear's concha is not closed completely.

When the ear's concha is not closed completely in this manner, the output is lowered especially in the lower frequency range of the acoustic characteristics with the result that optimum electro-acoustic characteristics cannot be realized.

For maintaining the optimum acoustic characteristics as described above, it is necessary that the ear pad ring 107 be formed of a softer material and with an increased thickness so that it may be deformed radially more easily and with a larger amount of deformation. However, when the housing 102 is mounted to or detached from the ear's concha, a stress is applied to the ear pad ring 107 tending to displace the ear pad ring 107 away from the housing 102 in the directions shown by arrow F in Fig. 1 under the force of friction with the inner wall of the ear's concha. When the ear pad ring 107 is formed of a soft and pliable material, the ear pad ring is deformed easily under such stress. When the ear pad ring 107 is deformed under stress in this manner, both the aforementioned engaging and auxiliary securing means tend to be loosened so that the ear pad ring may be detached from the rib 102a.

In short, when the material of the ear pad ring is formed of a softer material, the size range of the ear's conchae into which a given ear pad ring can be introduced is enhanced, while the contact feel of the apparatus with the ear's concha is improved. However, when the ear pad ring is formed of a softer material, the ear pad ring is more likely to be detached from the housing, so that durability of the earphone unit is not ensured. For this reason, the desired durability may only be ensured at the sacrifice to some extent of the aforementioned acoustic characteristics or contact feel.

The same inconvenience as experienced with the ear pad ring arises with the cord bush 108, that is,

when the cord bush is formed of a softer material, the connection cord 103 may be protected more reliably, however, the cord is more likely to be detached from the housing 102.

It has been proposed, in an electro-acoustic transducer in which the housing encloses the speaker unit, for the ear pad ring and the cord bush to be moulded integrally from the same material thus facilitating the assembly operation and improving the durability. However, in this electro-acoustic transducer, since the portion contacting the ear's concha and the housing holding the speaker unit are formed of the same material, a material suitable for both the contacting portion and the housing cannot be used, such that the contacting portion and the housing need be formed of a material having only moderate hardness.

Patent Specification US-A-3 671 685 discloses an audio headset with earpieces each of which comprises a projection of a rigid plastics material with a sound channel therethrough and a groove around the outer face to receive a projecting rib of a tip of soft elastic plastic in the form of a tube. A tip of suitable outside diameter is chosen to suit the size of the ear canal of the user in whose ear the tip is to be received.

According to the invention there is provided an electro-acoustic transducer of the kind suitable for insertion in the ear comprising a housing enclosing an electro-acoustic transducer device, the housing being formed of a synthetic resin and including an opening through which the diaphragm side of the electro-acoustic transducer device is exposed to the outside, and

an ear pad formed as a ring provided at and permanently fixed to the outer surface of the perimeter of the opening, the outer periphery of the ring being softer and more pliable than the housing;

characterised in that the housing has a main body which is formed with the ring by double-shot moulding;

the ring extends to the rear of the transducer device and is integral with the compensating means, at the rear, in the form of an acoustic pipe comprising a frame having a through-hole therein to compensate the low frequency portion of the frequency response of the transducer;

the ring is also formed integral with a cord bush holding a cord connected to the electro-acoustic transducer device; and

the ring, the frame and the cord bush are all formed of a synthetic resin material having a lower rubber hardness than the rubber hardness of the material of the main body of the housing.

In such an electro-acoustic transducer good use feel, positive protection of the connection cords and sufficient durability may be achieved. When used as a headphone unit, the ear pad ring and the cord bush will not be detached from the housing even after repeated use of the transducer.

Thus at least the outer surface portion of the housing around the opening by which the sound radiating side or sound input side of the electro-acoustic transducer unit is exposed to the outside is formed of a material other than the material of the remaining portion of the housing, so that these portions are formed to be different in colour and/or material, with the portions strongly bonded to each other.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:-

Fig. 1 is a sectional view showing the construction of a headphone unit of previously proposed kind;

Fig. 2 is a sectional view showing the construction of a headphone unit according to the invention; and

Fig. 3 is a perspective view showing the headphone unit of Figure 2;

Referring to Figures 2 and 3, a headphone unit to be used in the ear's concha includes a housing 2 enclosing a speaker unit 1 forming an electro-acoustic device.

The speaker unit 1 is provided with a magnetic circuit including a magnet and a yoke, a coil bobbin driven by the magnetic circuit, and a diaphragm attached to the coil bobbin. Electric signals supplied to the coil bobbin are converted into sounds by the vibration of the diaphragm in well-known manner.

The housing 2 is of a size such that it can be introduced into the ear's concha, and is provided with an opening 2a so that a sound radiating side of the speaker unit 1 faces to the outside at the opening 2a. A connecting cord 3 to supply the electric signals to the speaker unit 1 has its terminal portion 4 connected as by soldering to an input terminal 5 of the speaker unit 1. The connecting cord 3 exits the housing 2 by way of a cord extraction opening 6.

The housing 2 includes a main body 7 covering the rear side of the speaker unit 1, an ear pad 8 formed around the opening 2a and a cord bush 9 provided on a line of extension of the cord lead-out opening 6.

Since it is necessary to hold the shape of the housing 2 in its entirety and to provide good acoustic effects, the main body 7 is formed of a relatively stiff material having a rubber hardness of the order of 90 degrees, such as ABS resin.

The ear pad 8 is formed on that portion of the perimeter of the opening 2a of the housing 2 that contacts with the inner wall of the ear's concha by what is called double-shot moulding.

By "double-shot moulding" is meant a method of moulding including the steps of initially forming a portion of a first material using a first metal mould, placing the portion of the first material in a predetermined position in a second metal mould and injecting and moulding a second material in the second metal

mould to form a moulded article composed of the first and the second materials rigidly connected and united to each other. When a two-colour injection moulding machine is employed, after the portion of the first material is moulded, the predetermined movable portion of the metal mould may be shifted and the second material injected and moulded to form a moulded article formed of two kinds of materials.

For providing a soft feel on contact of the ear pad 8 with the inner wall of the ear's concha, and for making it possible to introduce the ear pad 8 into ear conchae of different sizes, the ear pad 8 is formed of a relatively soft and pliable material having a rubber hardness of about 60 degrees, such as urethane, or an elastomeric material having a still lower rubber hardness. The material of the ear pad 8 is of a different colour to the material of the main body 7. The inner side of the ear pad 8 is formed with a groove 8a for holding the speaker unit 1. The speaker unit 1 is held in position with its peripheral portion received within the groove 8a.

The cord bush 9 protects the portion of the connecting cord 3 that exits by way of the cord extraction opening 6 from accidents such as breakage caused by repeated flexure, and is formed with a cylindrical shape on the line of extension of the cord extraction opening 6. The cord bush 9 is formed by the double-shot moulding from the same material as that of the ear pad 8. A plurality of annular grooves 10 are formed on the outer peripheral surface of the cord bush 9 to permit the cord bush 9 to be flexed particularly readily. The portion of the connecting cord 3 that exits through the cord extraction opening 6 is supported by the cord bush 9 so that it may be bent smoothly as it is sheathed in the cord bush 9 on application of an external force to prevent incidental breakage which might otherwise be caused by flexure of the connecting cord in contact with the edge of the cord extraction opening 6.

A through-hole 11 is formed at the portion of the main body 7 facing the rear surface of the speaker unit 1. The through-hole 11 is provided for improving acoustic effects. The perimeter of the through-hole 11 is designed as a through-hole frame 12. By providing the through-hole 11 on the rear side of the main body 7, optimum frequency response characteristics may be produced up to the low frequency range of the frequency response curve even for a small-sized speaker unit. The through-hole 11 and the frame 12 thus make up an acoustic pipe which compensates for decrease in response in the low frequency range of the frequency response curve. The frame 12 is provided mainly for decoration purposes and is formed integral with and of the same material as the ear pad 8 and the cord bush 9 by the double-shot moulding.

The ear pad 8, the cord bush 9 and the frame 12 are formed simultaneously from the same material and are connected with one another by runners 13.

The runners 13 are formed to extend along the inner surface of the main body 7.

Holding of the housing 2 in its entirety and optimum acoustic properties are ensured by the main body 7, while the soft feel of the portion of the unit contacting with the ear's concha is ensured by the ear pad 8 and the cord bush 9. The main body 7, the ear pad 8 and the cord bush 9 are formed by double-shot moulding of two different kinds of material that are firmly bonded together by virtue of double-shot moulding and are unlikely to be peeled off from each other after repeated or prolonged usages.

Thus as described hereinabove, the outer surface of the opening of the housing by which at least the diaphragm of the electro-acoustic transducer is exposed to the outside, is formed of a material different from the material of the remaining portion.

Hence, the portion of the housing that is formed by double-shot moulding is formed of materials different in colour and/or hardness and that are united strongly to each other.

Therefore, when the so-called inner ear type headphone unit is constituted in accordance with the invention, the portion of the housing contacting with the inner wall of the ear's concha is preferably formed of a soft and pliable material to provide a soft contact feel with the ear's concha, while the main body of the housing is formed of a relatively stiff material to provide optimum acoustic characteristics and reliable holding of the speaker unit. In addition, the two materials different in hardness are form-lockingly connected rigidly to each other to ensure durability of the headphone unit.

The number of component parts can also be reduced and the assembly operation can be simplified since the operation can be achieved by simply fitting the electro-acoustic transducer unit, such as the speaker unit, into the housing formed by double-shot moulding.

Claims

1. An electro-acoustic transducer of the kind suitable for insertion in the ear comprising a housing (2) enclosing an electro-acoustic transducer device (1), the housing (2) being formed of a synthetic resin and including an opening (2a) through which the diaphragm side of the electro-acoustic transducer device is exposed to the outside, and an ear pad formed as a ring (8) provided at and permanently fixed to the outer surface of the perimeter of the opening (2a), the outer periphery of the ring (8) being softer and more pliable than the housing (2);
characterised in that the housing (2) has a main body (7) which is formed with the ring (8) by double-shot moulding;

the ring (8) extends to the rear of the transducer device (1) and is integral with the compensating means, at the rear, in the form of an acoustic pipe comprising a frame (12) having a through-hole (11) therein to compensate the low frequency portion of the frequency response of the transducer;

the ring (8) is also formed integral with a cord bush (9) holding a cord (3) connected to the electro-acoustic transducer device (1); and

the ring (8), the frame (12) and the cord bush (9) are all formed of a synthetic resin material having a lower rubber hardness than the rubber hardness of the material of the main body (7) of the housing (2).

2. An electro-acoustic transducer according to claim 1, wherein the ring (8), the frame (12) and the cord bush (9) are formed of a material different in colour to the material of the main body (7) of the housing (2).

Patentansprüche

1. Elektro-akustischer Wandler, der in das Ohr einsetzbar ist, mit einem Gehäuse (2), das eine elektro-akustische Wandlervorrichtung (1) aufweist, wobei das Gehäuse (2) aus einem Kunststoff gebildet ist und eine Öffnung (2a), durch die die Membranseite der elektro-akustischen Wandlervorrichtung nach außen frei ist, und ein Ohrpolster in Ringform (8) aufweist, das an der Außenseite des Umfangsbereichs der Öffnung (2a) vorgesehen und mit dieser fest verbunden ist, wobei der äußere Umfangsbereich des Rings (8) weicher und biegsamer als das Gehäuse (2) ist, dadurch gekennzeichnet, daß das Gehäuse (2) einen Hauptkörper (7) aufweist, der mit dem Ring (8) durch einen Doppelspritzguß gebildet ist, der Ring (8) sich zu der Rückseite der Wandlervorrichtung (1) erstreckt und einstückig mit einer Ausgleichseinrichtung an der Rückseite in Form einer akustischen Röhre ausgebildet ist, die einen Rahmen (12) mit einem Durchgangsloch (11) darin aufweist zum Ausgleich des niedrigen Frequenzanteils des Frequenzgangs des Wandlers, der Ring ebenso einstückig mit einer Kabelhülse (9) gebildet ist, die ein Kabel (3) hält, das mit der elektro-akustischen Wandlervorrichtung (1) verbunden ist, und der Ring (8), der Rahmen (12) und die Kabelhülse (9) alle aus einem Kunststoffmaterial mit einer niedrigeren Gummihärte als die Gummihärte des Materials des Hauptkörpers (7) des Gehäuses (2) gebildet sind.

2. Elektroakustischer Wandler nach Anspruch 1, dadurch gekennzeichnet, daß der Ring (8), der Rahmen (12) und die Kabelhülse (9) aus einem Material mit unterschiedlicher Farbe zu dem Material des Hauptkörpers (7) des Gehäuses (2) gebildet sind.

Revendications

1. Transducteur électro-acoustique de la sorte appropriée pour introduction dans l'oreille, comprenant : un boîtier (2) renfermant un dispositif transducteur électro-acoustique (1), le boîtier (2) étant fait d'une résine synthétique et incluant une ouverture (2a) par laquelle le côté diaphragme du dispositif transducteur électro-acoustique est exposé à l'extérieur ; et

un tampon d'oreille (8) de forme annulaire disposé au droit de la surface extérieure de la périphérie de l'ouverture (2a) et fixé de façon permanente à celle-ci, la périphérie extérieure du tampon annulaire étant plus molle et plus souple que le boîtier (2) ;

caractérisé en ce que le boîtier (2) possède un corps principal (7) qui est formé avec le tampon annulaire (8) par moulage en deux phases ;

en ce que le tampon annulaire (8) s'étend jusqu'à l'arrière du dispositif transducteur et est d'un seul tenant avec un moyen de compensation, à l'arrière, sous la forme d'un tuyau acoustique comprenant un cadre (12) ayant à l'intérieur un trou traversant (11) pour compenser la partie basses fréquences de la réponse en fréquence du transducteur ;

en ce que le tampon annulaire (8) est également formé d'un seul tenant avec une traversée de cordon (9) contenant un cordon (3) raccordé au dispositif transducteur électro-acoustique (1) ; et

en ce que le tampon annulaire (8), le cadre (12) et la traversée de cordon (9) sont tous formés d'une matière à base de résine synthétique ayant une dureté plus basse que la dureté de la matière du corps principal (7) du boîtier (2).

2. Transducteur électro-acoustique selon la revendication 1, dans lequel le tampon annulaire (8), le cadre (12) et la traversée de cordon (9) sont formés d'une matière d'une couleur différente de la matière du corps principal (7) du boîtier (2).

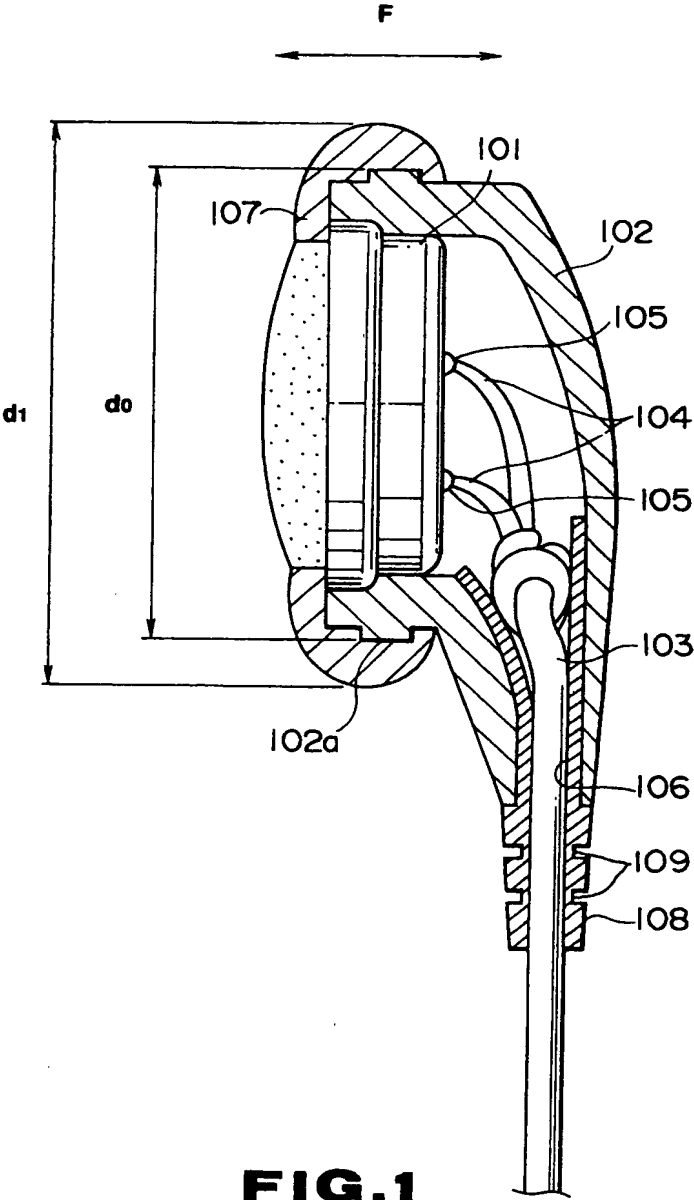


FIG.1

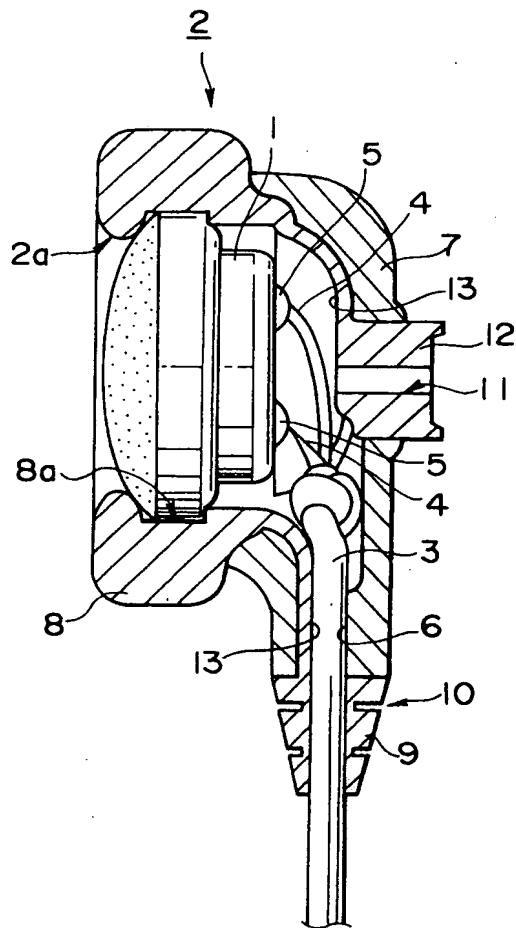


FIG. 2

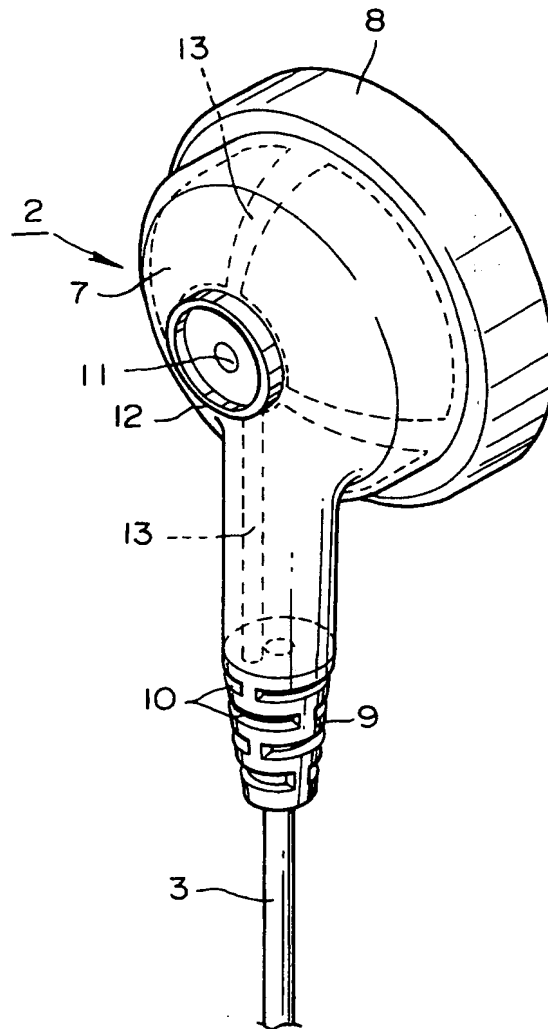


FIG. 3